CLAIMS

What is claimed is:

1. A method of magnetron sputtering, the method comprising:

forming a first closed plasma loop;

forming an open plasma loop within the first closed plasma loop; and

sputtering a target with ions from the open plasma loop and the closed plasma loop.

2. The method of claim 1 further comprising:

forming a second closed plasma loop within the first closed plasma loop.

3. The method of claim 1 wherein the open plasma loop flows in the same direction as the first closed plasma loop.

4. The method of claim 1 wherein the target comprises a planar target.

5. The method of claim 1 wherein the target comprises a hollow target

6. The method of claim 1 wherein forming an open plasma loop comprises:

forming a separatrix surface such that a portion of the plasma loop enclosed by the separatrix is cut-off from the plasma by the target.

7. The method of claim 1 wherein the open plasma loop is formed by physically blocking a return path of a separatrix.

8. The method of claim 1 further comprising:

generating a rotating magnetic field to rotate the open plasma loop.

9. A magnetron sputtering apparatus comprising:

a target; and

a magnetic circuit configured to generate an open plasma loop within a closed plasma loop.

10. The apparatus of claim 9 wherein the target comprises a planar target.

11. The apparatus of claim 9 wherein the target comprises a hollow target.

12. The apparatus of claim 9 wherein the magnetic circuit is part of a rotating magnetic array.

13. The apparatus of claim 9 wherein the magnetic circuit comprises:

a first set of magnets oriented parallel to a surface of the target, wherein the first set of magnets generate the open plasma loop.

14. The apparatus of claim 9 wherein the magnetic circuit comprises:

a first set of magnets oriented perpendicular to a surface of the target, wherein the first set of magnets generate the open plasma loop.

15. A method of magnetron sputtering, the method comprising:

providing a target; and

sputtering the target with ions of an open plasma loop.

16. The method of claim 15 wherein the target comprises a hollow target.

17. The method of claim 15 wherein the target comprises a planar target.

18. The method of claim 15 wherein the open plasma loop is rotated.

19. The method of claim 15 further comprising:

forming a first closed plasma loop enclosing the open plasma loop.

20. The method of claim 19 further comprising:

forming a second closed plasma loop within the first closed plasma loop.

21. The method of claim 20 further comprising:

rotating the second closed plasma loop.

22. A method of magnetron sputtering, the method comprising:

forming a first separatrix to confine a first plasma;

confining the first separatrix within a second separatrix; and

depositing a thin film on a substrate with ions escaping through a null region of the second separatrix.

23. The method of claim 22 further comprising:

confining the second separatrix within a third separatrix; and

wherein the ions escaping through the null region of the second separatrix pass through a null region of the third separatrix to deposit onto the substrate.

24. The method of claim 22 wherein the ions escaping through the null region of the second separatrix are sputtered off a hollow target.

25. The method of claim 22 wherein the ions escaping through the null region of the second separatrix are sputtered off a planar target.

26. A method of magnetron sputtering, the method comprising:

forming a closed plasma loop in a magnetron sputtering chamber; and

forming a first open plasma loop, the first open plasma loop having a beginning on a path defined by the closed plasma loop and an end on a region of the chamber.

27. The method of claim 26 wherein the region includes the path defined by the closed plasma loop.

28. The method of claim 26 wherein the region comprises a volume of the chamber that is not on a path of a plasma loop.

29. The method of claim 26 wherein the region includes a path of a second open plasma loop.

30. The method of claim 26 further comprising:

forming a second open plasma loop, the second open plasma loop having a beginning on the path defined by the closed plasma loop and an end on a path defined by the first open plasma loop.

31. The method of claim 30 further comprising:

forming a third open plasma loop, the third open plasma loop having a beginning on the path defined by the closed plasma loop and an end on a path defined by the second open plasma loop.

32. The method of claim 26 further comprising:

a first separatrix confining the closed plasma loop, the first separatrix having a null region through which ions may escape to reach a substrate.